

Description of a New Deep-Water Calcareous Sponge (Porifera: Calcarea) from Northern California¹

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ABSTRACT: A new species, *Sycon escanabensis* Duplessis & Reiswig, is described from material retrieved by submersible from 3500 m depth in the Escanaba Trough, central Gorda Ridge, off northern California. The species differs from all other members of the genus by the combination of conspicuous tripartite body organization and slender, lancet-head diactins that ornament the external surface and the oscular margin. This is the first deep-water (> 1000 m) calcareous sponge described from the North Pacific Basin.

MEMBERS OF THE PORIFERAN class Calcarea have often been considered to be restricted to the upper 200 m of the ocean by physical factors (Bergquist 1978), namely the calcium carbonate compensation depth, below which exposed calcareous skeletons pass fairly rapidly into solution (Gage and Tyler 1991). Indeed, the skeletal remains of calcareous sponges are rarely encountered in sediments at depths beyond 2500 m, suggesting their absence as members of deep-water faunal communities. In recent years, however, an increasing number of living calcareous specimens have been discovered at depths below 1000 m. These reports have been primarily from the Norwegian, Greenland, and Arctic Seas (Arnesen [1920]: 1 location; Borojević and Graat-Kleeton [1965]: 7 locations; Reid [1968]: 3 locations; Tendal [1989]: 40 locations). The deepest specimen reported from the Atlantic region is *Sycon abyssale* from 4000 m (Borojević and Graat-Kleeton 1965). This series of unexpected occurrences was thought to be attributable to the unusual combination of low temperatures and high overturn (dynamic instability) in this region,

modifying the solution dynamics of calcium carbonate. However, Vacelet (1989) has found calcareous sponges at eight deep locations in the Mediterranean Sea, the deepest at 2775 m, casting serious doubt upon the unique environment hypothesis.

These calcareous sponges have all been, with rare exception, members of the cosmopolitan genus *Sycon*. The only deep-water calcareous sponge reported from the North Pacific is an unidentified specimen discovered in the Kurile Trench at 5045 m (Koltun 1970). Here we describe a new deep-water *Sycon* species (four specimens) from the Northeast Pacific. This is only the second report of occurrence of deep-water Calcarea from this region and the first report with a full species determination.

MATERIALS AND METHODS

The two complete specimens, after being photographed and measured, were grossly dissected to provide isolated body regions. These were bulk-stained in 1% erythrosin-B in 95% ethanol and either whole-mounted in Canada balsam on slides or embedded in paraffin for thick-sectioning by hand, deparaffinized in xylene, and mounted in balsam. Pieces used for spicule sampling were deparaffinized and digested in 5.25% sodium hypochlorite. Spicules were retained on 0.2- μ m pore-size nitrocellulose filters, which were water-rinsed, dried, cleared in xylene,

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and mounted in balsam on slides for light microscopy. Spicules were measured by computer with a microscope-coupled digitizer. Spicule drawings were prepared from video-captured light-microscope images imported into a computer drawing program and traced on-screen.

Samples for scanning electron microscopy (SEM) were digested in 5% sodium hypochlorite and were either captured on 0.2- μ m pore-size polycarbonate membrane filters or deposited directly onto cover glasses after rinsing in distilled water. After gold-palladium coating, specimens were viewed and photographed with an SEM (JEOL JSM-840). Data are reported as mean \pm SD (range, number of measurements). Specimens have been deposited at the California Academy of Sciences, Invertebrate Zoology Division, (CASIZ), Golden Gate Park, San Francisco, California.

SYSTEMATIC TREATMENT

Class CALCAREA Bowerbank, 1864

Subclass CALCARONEA Bidder, 1898

Order LEUCOSOLENIIDA Hartman, 1958

Family SYCETTIDAE Dendy, 1892

Genus *Sycon* Risso, 1826

Sycon escanabensis Duplessis & Reising, n. sp.

Figures 1–3

TYPE MATERIAL: Holotype: CASIZ 113575, length 5.6 mm (complete specimen), Escanaba Trough, Gorda Ridge, off Northern California; 40.99° N, 127.494° W; 6 September 1988; 3500 m; col. R. Zierenberg; DSS *Laney Chouest* and DSSV *Sea Cliff*, dive no. 766.

Paratypes: CASIZ 113576, length 3.4 mm (complete specimen); CASIZ 113577, 1.3 mm (oscular tube only); CASIZ 113578, 1.3 mm (oscular tube only); collection data as for holotype.

DIAGNOSIS: *Sycon* with a distinctly tripartite body (oscular tube, trunk, and stalk), and short, thin, lancet-head diactins projecting from oscular margin and surrounding external surface.

DESCRIPTION: Specimen: A complete specimen of *Sycon escanabensis* shows clear tripartite macrostructure (Figure 1a), consisting of an oscular tube, a trunk, and a stalk; total length: 3.4–5.6 mm; width: 2.4–2.6 mm. Ocular tube length: 0.9–1.2 mm; diameter: 0.9–1.1 mm. Ocular tube (Figure 1a,c) lacks choanocytes and serves only to convey exhalent water from the trunk to the superior osculum. It is composed of two bounding epithelia enclosing a well-ordered spicular skeleton of sagittal triactins, sagittal ray directed basally, and a small proportion (ca. 5%) of tetractins, curved atrial ray directed into the tube lumen and toward the osculum. Thin lancet-head diactine spicules form a marginal fringe at osculum and ornament the external surface of the tube in an oblique, osculum-directed orientation.

The trunk contains the entire choanocyte population of the sponge in the flagellated chambers (radial canals). Externally the trunk is conulose and hispid, and the cones distally ornamented with small lancet-head diactins. Trunk length: 1.8–3.6 mm. The flagellated chambers are coalescent for most of their length (Figure 1b), a distinctive characteristic of *Sycon*. The chambers themselves measure 324–363 μ m wide and 592–667 μ m long. Small oocytes at low density (1–4 per flagellated chamber) occur in the holotype. Tetractins, common at the intersection of the flagellated chambers and atrial cavity, have their atrial ray oriented as in the oscular tube, but the primary rays are arranged to coincide with margins of the radial canal junctions, not the longitudinal axis of the sponge.

The tapered basal stalk apparently serves only for attachment and support; it lacks choanocytes, an axial atrial cavity, and external diactin ornamentation. Stalk length: 0.90–0.95 mm. Its skeleton of triactins and tetractins is less ordered than those of the other body regions. Small sand grains are attached to the stalk base of the complete paratype, CASIZ 113576.

Spicules: Triactins occur in two forms: sagittal (Figure 2a–c) and irregular (Figure 2d); they are semitetrahedral (nonplanar) (Figure 1d). Ray length: 231 ± 91 μ m (28–

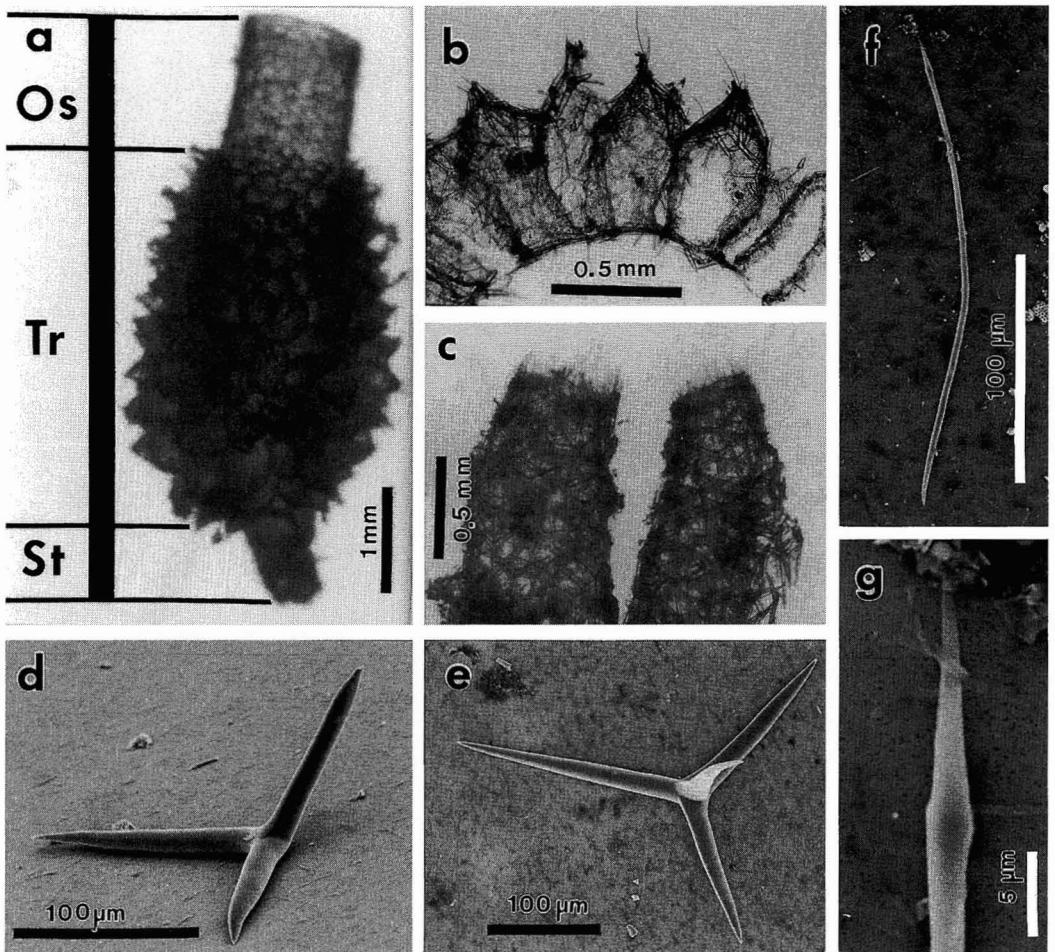


FIGURE 1. *Sycon escanabensis*, n. sp.: *a*, holotype, showing tripartite structure (Os, osculum; Tr, trunk; St, stalk). *b*, cross section of the body wall of the holotype, showing radial canals, 1% erythrosin-B stained. *c*, the two incomplete paratypes (oscular tubes) showing diactins of the oscular fringe. *d*, triactine spicule, clearly nonplanar in form (SEM). *e*, tetractine spicule, with atrial ray projecting vertically (SEM). *f*, diactine spicule (whole). *g*, diactine spicule (lancet head).

559 μm , 576); ray thickness: $18.4 \pm 8.5 \mu\text{m}$ (5.6–47.9 μm , 225). Medium-sized sagittal triactins (Figure 2*b*) occur in oscular tube oriented with sagittal ray directed basally, and in lateral walls of the radial canals. Larger sagittal triactins (Figure 2*a*) occur at proximal and distal ends (terminal cones) of the radial canals. Very small triactins (Figure 2*c*) occur throughout the specimens. Frequency analysis of the unpaired angle of sagittal triactins (Figure 3) shows a broad,

continuous distribution, establishing that only a single class of this spicule form is present; $\angle = 125 \pm 11^\circ$ (97–159°, 204). Irregular triactins (Figure 2*d*) occur throughout the specimen in small numbers and more commonly in the stalk region; largest angle: $\angle = 134 \pm 12^\circ$ (124–177°, 105).

Tetractins (Figures 1*e*, 2*e*) line the atrial cavity, with atrial ray projecting inward and upward toward the osculum. They are also present in the oscular tube wall and in the

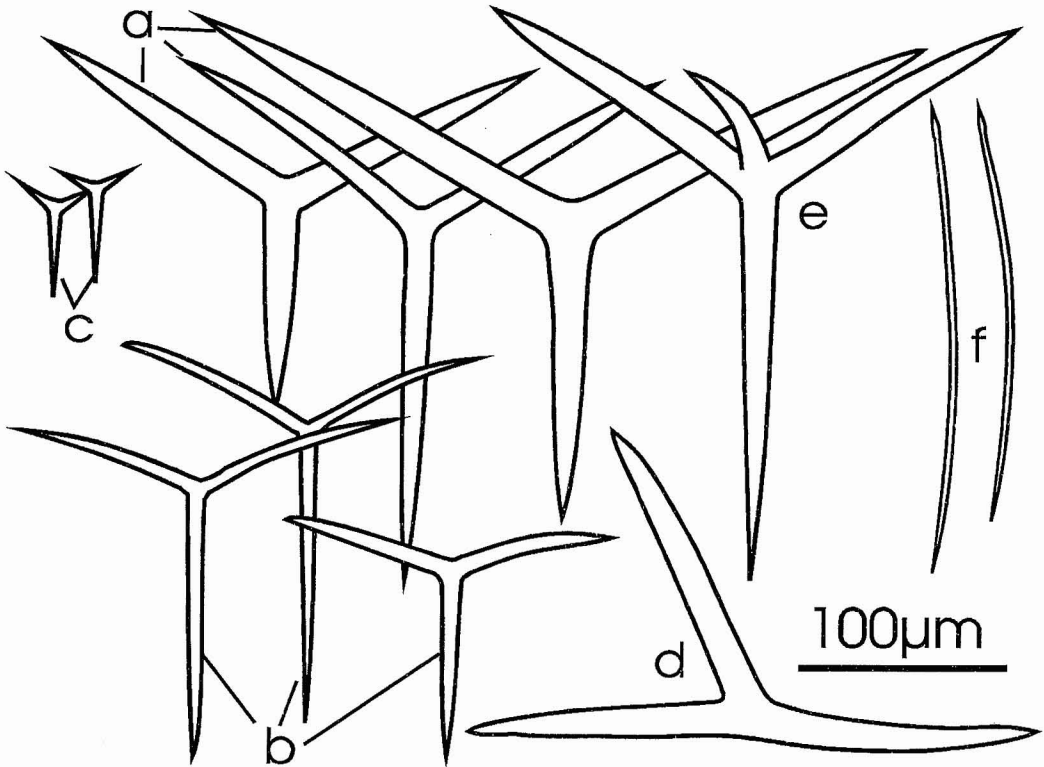


FIGURE 2. Spicules of *Sycon escanabensis*, n. sp.: a, large sagittal triactins. b, medium sagittal triactins. c, small sagittal triactins. d, irregular triactin. e, tetractine spicule. f, diactine spicules.

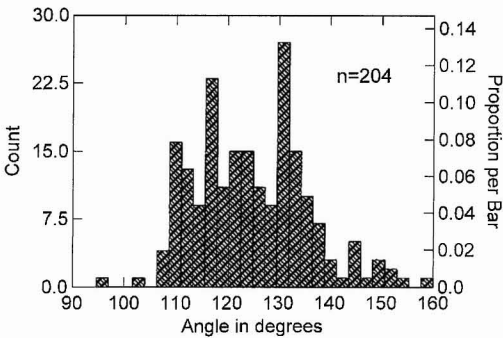


FIGURE 3. Histogram of unpaired angle of sagittal triactine spicules of *Sycon escanabensis*, n. sp.

trunk region at intersections of the radial canals. Dimensions of primary rays as for triactins (above); atrial ray length: $165 \pm 40 \mu\text{m}$ (93–228 μm , 20).

Diactins (Figures 1f, 2f) always occur projecting lancet head out from the external surface on the terminal fringe of the oscular tube, along its outer walls, and at tips of the cones of the radial canals. This distinctive lancet-shaped head (Figure 1g) also occurs in other *Sycon* species. Length: $228 \pm 59 \mu\text{m}$ (73–341 μm , 100); thickness: $2.9 \pm 0.7 \mu\text{m}$ (1.4–5.1 μm , 100).

ETYMOLOGY: The species name is derived from the geographic location of collection, the Escanaba Trough.

REMARKS: This species is assigned to the genus *Sycon* by virtue of coalescence of its radial canals. Several other species of this genus also show tripartite body organization, including *S. ampulla*, *S. caminatum*, *S. humboldtii*, *S. raphanus*, and *S. sycandra* (Burton 1963). The new species differs from *S. am-*

pulla by its solitary form (*S. ampulla* is colonial) and its solid stalk (that of *S. ampulla* is hollow). All of these tripartite forms differ from *S. escanabensis* in their possession of much larger diactine spicules.

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